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RADIOACTIVE WASTE: THE PROBLEM AND ITS MANAGEMENT

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ABSTRACT

Radioactive waste is an arising concern in present era because of increasing nuclear activities and nuclear weapon activities related to defence. It is a significant problem to handle and protect the environment for safeguarding future generations. This study deals with the global problem of radioactive waste problems and its management. It consists of various aspects related to radioactive waste and also, caters to the cause of concern, effects of radioactive waste, classification and approaches of radioactive waste, involvement of waste magnitudes and prospective solutions, disposal of radioactivity and its management. With increasing nuclear power and arsenal, it is important to monitor and immobilize the waste and safe respositories deposition.

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1. INTRODUCTION

During wars, there is extensive usage of nuclear weapons and plutonium based weapons. There are so many nuclear complexes in various countries which includes nuclear reactors for production of plutonium. It also reprocesses plants for extraction of plutonium. It includes large level of contamination in reprocessing of plans and irradiated fuel which acts as radioactive collection. The dumping of nuclear reactors and radioactive waste in the seas indicates high damages to the environment (Ojovan, 2014). It is also indicated that various processed and unprocessed nuclear waste are found in sea and submarines. The management of radioactive waste is very casual in most of the nations. Therefore, it is significant to understand basics of radioactive waste and related aspects of waste management.

2. RADIOACTIVE WASTE

There are two basic nuclear reactions namely nuclei fission 235 U and 239 U. The fusion of these two elements results in release of radioactive elements and enormous energy. The fission reaction also leads to vast energy releases in reactors of nuclear power plant. There is no control on vast releases of energy and uncontrolled releases are possible in hydrogen and atom bombs (Gofman, 2010). Radioactive waste is basically huge collection of radioactive materials and mostly, generates due to nuclear power generation and other fissions of nuclear technology such as medicine and research. In various industrial processes including nuclear industry, there are so many unusable products which are considered as waste but they are very hazardous. It can be considered that any waste that includes nuclear radiations is radioactive waste.

2.1. Natural radioactivity

This is a usual producer of radioactive waste. Over the years, the earth surface and terrestrial crust is a huge reservoir of radioactivity. The sand mounds, mineral springs and volcanic eruptions also have certain amount of radioactive materials. All type of substances contains radioactive elements originated from nature (Shipman, 2007). Another source of radioactive waste is activities of industrial mining where minerals are explored and exploited. The primordial material is extracted from earth which contains radioactivity. It also refers to radioactive materials occurring naturally and they are quite ubiquitous like residual waste. There are various radiations which are exposed to general public and workers.

2.2. Artificial radioactivity

Radioactivity has been discovered many years ago but after the World war, fission processes has also been discovered. The regular activities conducted by human beings have added to artificial radioactivity at maximum extent (Anderson, 2012). There are two major sources i.e. military nuclear program which includes testing of underground nuclear weapon and civilian nuclear programs which includes applications of radioactive materials in medical and other industries and produces nuclear power.

2.3. Nuclear fuel cycle

There are various nuclear operations conducted by civilians which lead to radioactivity. The uranium production from mining and its use in reactors, chemical processing and radioactive waste accumulation is covered and referred as nuclear fuel cycle (Ojovan, 2014). The ores are mined in uranium mines and contains fraction separated from ore and leave the entire ore in tailings. The fresh uranium fuel is quite radioactive (Rao, 2001). After enough utilization of fuel in reactors, the spent fuel contains fission of debris, unutilized uranium and actinides. It is referred to as irradiated fuel and very radioactive.

3. CAUSE FOR CONCERN

Either types of radioactive waste such as natural or artificial is potential harm for radioactive exposure to human beings through multiple channels. Any route of radioactive materials is directly exposed to air breathed by people and food consumers by people. This exposure decides the effects or results of radioactive materials and it may occur to specific organs or whole body of human beings (Hensing, 2005). High exposure can also lead to cancer. The toxicity of radioactive materials can be

quantified according to level of nuclear power hazard, availability of nuclides, activity of nuclides and permissible intake of nuclides. It also depends on various other factors such biological and physical life, organ sensitivity, radiation from ionizing power of nuclides and energy of radiation emissions. There are no alternative energy sources and nuclear power is only source available to mankind. The nuclear power plants are also managed to various controls of radiation protection practices (Attix, 2006). The radioactive materials are capable of damaging the environment by generation of nuclear power plants which is the major cause of concern for environment as well as human beings.

4. RADIATION EFFECTS

There is lot of inhabitants on the planet which are exposed to natural occurrences of radiation in constant manner and they have hazardous effects. Minor sources of background radiation care cosmic rays of sun and stars and other radioactive materials from soil and rocks. The human beings are also exposed to ionizing radiation from natural sources and other medical therapies like X-ray techniques. The radiation therapy is also targeted to affected tissues of individuals (Wainwright, 2013). There are major effects of large radiation doses. The ionizing radiation can also affect the DNA i.e. genetic material and other body cells (Gofman, 2010). The fast doses of radiation affect biological body processes. The radiation dosage can be acute or chronic. The body can tolerate only chronic doses. The genetic and somatic radiation effects of radioactive materials have potential for development of cataracts and cancer. It also has heritable or genetic effects which may appear in future generations of exposed people as a result of radiation damages to reproductive cells.

5. QUANTIFICATION OF NUCLEAR WASTE

The radioactive waste level is measured in volume or tonnage terms. Another way of measuring the radioactivity waste is in bequerels. Both the measurable units are utilized because individuals need not to know the volume of waste for disposal and handling purposes and contained radioactivity. The nuclear waste derived from natural sources includes mining and other related operations results in production of radioactive waste of few EBq and sea is considered as repository of thousands of EBq radioactivity (Wilmarth, 2004). It can be estimated that the military nuclear operations results in release of thousands of nuclear debris in atmosphere. The weapon production materials also results in thousands of EBq of residual waste. Whereas, the nuclear submarine accidents and nuclear power satellites results in few EBq of radioactive waste. It is also estimated that nuclear waste is increasing at rate of EBq per year due to production of nuclear power (Cohen, 2008). The huge nuclear power plants with capacity of 1000 MW capacity produces approximately 28 tonnes of high level radioactive waste, 465 tonnes of low level radioactive waste and 320 tonnes of intermediate level of radioactive waste.

6. CLASSIFICATION OF RADIOACTIVE WASTE

The radioactive waste can be classified as low level or high level of radioactive waste.

6.1. Low-level radioactive waste

The radioactive waste which is not high or intermediate level is termed as low level radioactive waste. The volume of low level radioactive waste can be more than high level or intermediate level but radioactivity contained in low level radioactive waste is

less in significant manner and have shorter half lives than isotopes in high or intermediate level radioactive waste. There are large amounts of waste in small radio nuclides such as shielded materials, air filters, laboratory equipments, glove boxes and other contaminated equipments constitute low level radioactive waste (Cochran, 2009). The half lives of radioactive isotopes and radioactivity level in low level waste are quite small. When waste is stored for period of 20 to 50 years and allows radioactive isotopes to decay low level waste. However, low level radioactive waste is not very hazardous.

6.2. High-level radioactive waste

The high level radioactive waste is considered as waste including liquid effluents and spent fuel which arises from reprocessing of spent solids and fuel and get converted into liquid waste. It also consists of material from nuclear reactor or weapons. The waste includes plutonium, uranium and other radioactive elements at the time of fission and made up of transuranics and fission fragments (Hashem, 2015). These components tend to decay at different times. Most of the radioactive isotopes are high level waste because of emitted radiation amounts and also, have long half lives. The high level radioactive waste is quite hazardous to overall environment.

7. DISPOSAL OF RADIOACTIVE WASTE

Waste disposal is very important measure to evaluate the effects of radioactive waste on environment. The radioactive waste is discarded with no intentions of retrieving it. The management of waste is the entire operations in sequence starting from waste generation to disposal. The solid waste is mostly based on three disposal methods i.e. recycling, landfill and incineration (Attix, 2006). The radioactive waste disposal has also adopted landfill as most sophisticated method. However, the incineration of waste like chemical contaminants is released in air. The radioactive waste cannot be treated in this manner because emissions will contain various radioactive materials. It requires fine filters for radioactive materials and other gaseous effluents. The radioactive waste can be recycled up to certain extent as radioactive elements can be recovered for cyclical use but it still leaves some part of high level radioactive waste. The radioactive waste management includes minimization of radioactive residues, handling of safe packing and safe disposal (Rao, 2001). It is very important to choose the site where radioactivity can be managed safely and technical expertise, finance is also required to result in environmentally protective and safe conditions. It includes security of acceptable protection level of human health, acceptable level of environment protection, acceptable impact of waste on future generations and effects on environment.

There are few approaches for disposal of radioactivity waste. It involves consideration of radioactive elements in context to half-live and chooses suitable handling method. The delay and decay approach can be adopted if radioactive elements are short lives. Another approach can be dilute and disperse to minimize the environmental hazards (Cohen, 2008). In case of long lived radioactivity, only approach is concentrate and contains and carries the waste concentration. The radioactive waste management can also be conducted by bringing the radioactivity to surface and alter the physical and chemical properties to increase the environment mobility.

8. OPTIONS FOR RADIOACTIVITY DISPOSALS

It is important to explore radioactivity disposal options and managing radioactive waste in efficient manner. The disposal of high level wastes can safeguard environment as well as human health. The most favorable solution for disposal of radioactive waste is isolation of radioactive waste from biosphere and human beings for certain period of time. The subsequent radio nuclides releasing from radio nuclides will result in unexposed radiation (Attix, 2006). The main purpose of this solution is to utilize stable geological environment which have retained the integrity for many years and provide appropriate capacity of isolation for long periods. Relying on geological environment is mainly based on consideration that geology is passive disposal system and does not require continued human involvement for perspectives of safety. The system safety is based on natural or engineered barriers (Sevior, 2006). The suitable options for disposal of radioactive waste can be geological disposal, ocean dumping and seabed burial. The execution of these options consists of some problems such as lack of education and awareness, environmental misconceptions, lack of technology proof, other legal, political, financial and social reasons.

8.1. Geologic disposal

Geologic disposal consist of geological various geological formations whether under seabed or continental crust. They act as radioactive waste disposal especially for long lived waste. Often, it is not chosen as a disposal option because of dirty and cheap procedures (Wainwright, 2013). The geological sites provide natural system of isolation which is stable over thousands of years. In general, the low level radioactive waste is disposed near by the surface or old mines. At the same time, high level radioactive waste is disposed in rocks (crystalline) or tuff or salty.

8.2. Ocean-dumping

There are many industrialized countries across the world which is practicing less expensive methods for disposal if radioactive waste and dump them to oceans. The dumping of radioactive waste has been increased in recent years. Though ocean dumping practice is banned in some countries but this problem still exist at large level and countries are continuously disposing nuclear waste in oceans (Wilmarth, 2004). It continues to dump all wastes in to oceans because there are no alternative methods.

8.3. Seabed disposal

This method of radioactive disposal is quite different from sea dumping and does not involve natural isolation of radioactive waste within the specific geographical arena. The deep oceans are main part of tectonic plate and located around 5 kilometers down the surface of sea and it is largely covered by very thick sedimentary clay. The canister contains high level of radioactive waste and they will be lowered into holes and vertically stacked. This method has some problems such as rock variability and local permeability. It is indicated that clay has lot of radioactive elements such as plutonium. And seepage of these radioactive elements in saline water is quite minimal (Anderson, 2012). The migration rates of radioactive elements over thousands of years will be of the order and radioactivity will diminish to specific levels below natural radioactivity in sea because of natural radioactive decay.

8.4. Subductive waste disposal method

This disposal method is proper disposal technology for nuclear waste. It is one of the most viable options for disposing radioactive waste and ensures that the relegated material will not return to overall biosphere. This disposal method eliminates weapon material and safeguards the environment (Hoare, 2008). It has a very fast process of removing the radioactive elements and therefore, it is considered as safest, economical, environment friendly, stable and most sensible method to eliminate nuclear waste (Ojovan, 2014). The high or low level radioactive waste is included in deep oceans which covers almost 70 percent of planet. Subduction process includes slides of tectonic plates and it gets reabsorbed in the mantle. The method helps in formation of radioactive waste respository in the subducting plate so as to carry the waste under earth crust. Then after, it will be diluted and dispersed through mantle.

8.5. Transmutation of radioactive waste

The transmutation of radioactive waste anticipates that transmutation devices can be utilized including the combination of charged particles and subcritical nuclear reactor for destruction of radioactivity (Yates, 2009). The fission of fragments is transmuted by capturing the neutrons and beta decay for production of stable nuclides. The activities of transmutation include various competing processes such as capturing neutron, radioactive decay, fission of neutrons etc. It produces large number of neutrons which are used for destroying the radioactive material which were kept in subcritical reactor.

8.6. Solar option

The solar option proposes that weapons including plutonium and other concentrated waste may be placed in earth orbit and accelerate to drop the waste into sun. It is theoretically possible but need lot of technical involvement and highly expensive as compared to other disposal methods (Cohen, 2008). It also requires ensuring that no waste will be released in case of failure of space transport system.

9. RADIOACTIVE WASTE MANAGEMENT

In many countries, consumption of electricity is measured by per capita and it is related to living standards of country. In the same manner, the minimum measure of radioactive waste has to be measured which is generated by specific country and related to the radioactive waste management magnitudes. There are considerable contribution of different countries such as 75 percent of France, 47 percent of Sweden, 42 percent of Korea, 34 percent of Japan, 31 percent of Germany, 28 percent of UK, 19 percent of USA, 14 percent of Russia, 12 percent of Canada and 3 percent of India (Macalister, 2013). It is clear that India has lowest contribution to the overall radioactive waste in the world. The management of radioactive waste is integral part of nuclear fuel cycle. The low and intermediate level radioactive waste arises from reactor operations and reprocessing of fuel and the liquid waste is retained as sludge after treatment of chemicals (Hafemeister, 2007). The solid radioactive waste is managed by incineration, compaction or bailed according to the nature of waste. The procedures of reverse osmosis, solid evaporation and immobilization with the use of cement matrix are also adopted depending on the type of waste. The engineered trenches are also utilized in near surfaced as disposal facilities for disposing solid waste and the disposal sites are under regular monitoring and surveillance. Moreover,

HEPA (High Efficiency Particulate Air) are also utilized for minimizing the air sourced radioactivity.

10. CONCLUSION

The study has explained various important aspects of radioactive waste and their consecutive effects on human health and environment. The disposal methods, their utility and cost effectiveness are also explained to understand the most feasible method for disposal of radioactive waste. It is indicated that there are various associated problems with the management of radioactive waste in long term and one of the major problem is humanity. The obstacles in managing radioactive waste management cannot be ignored but at the same time, government support, good sense of humanity, effective methods of radioactive material management can solve the problem. The efficient resources should be utilized in wise and well manner. Over the years, the issues of radioactive waste effects and management has been raised which led to various guidelines, technical and non-technical discussions such as retirement plan for nuclear facilities, decommissioning of nuclear facilities etc (Shipman, 2007). Furthermore, the issues of long term health and safety need to be addressed for better future of human health and environment. The options for disposing radioactive waste has been discussed in totality for understanding the possible methods for managing radioactive waste and safeguard the environment. It mainly includes natural system options and provides insight to the future solutions of repository. The problem of radioactive waste cannot get solved only by financial resources but also, technical, political, legal and social support in considerable manner.

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